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# Skill in Teaching, Assessed on the Criterion of Problem Solving

by
RICHARD L. TURNER
and
NICHOLAS A. FATTU

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## PREFACE

For the past several years the staff of the Institute of Educational Research has been engaged in investigating the problem-solving skills of elementary school teachers. Part of this work has been concerned with creating a body of concepts and procedures by which to guide the investigation, and part with the construction and validation of instruments designed to assess the problem-solving skills of elementary teachers, chiefly in the teaching of arithmetic and the teaching of reading. In an earlier bulletin (6) the authors outlined the concepts and procedures underlying the investigations to be made. In the present bulletin, they have brought together the findings of these investigations. Because these findings for the most part have been separately reported in technical detail (8, 9, 10), the purpose of the present bulletin is to synthesize them for those persons who are interested in teacher behavior but who are not concerned with the technical aspects of research in this area.

R.L.T.
N.A.F.

# VITA

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## INTRODUCTION

Background to the problem. Teaching is a complex activity; it may be viewed in many perspectives. The perspective one takes of teaching largely determines the sort of questions he asks about it and the sort of answers he gives to these questions. As the authors have previously suggested (6; 7)* the perspective in which one looks at teaching depends partly, if not wholly, upon his relationship to it. Thus, employing or supervising officials are most likely to look at teaching with a view toward judging the effectiveness with which a teacher discharges the particular functions which teachers working in their school systems are expected to fulfill. Since school systems are locally controlled, both these judgments and the functions judged may contain a good deal of local flavor.

Persons concerned with the preparation of teachers, on the other hand, may view teaching from a favorite theoretical perspective--as, for example, the guidance of learning activities in which pupil-teacher planning and teacher permissiveness are focal, the direction of learning activities involving considerable teacher dominance, the transmission of subject matter in which the organization and presentation of the subject is given paramount consideration, or perhaps the eclectic perspective in which elements of various theoretical viewpoints are combined.

For purposes of research, the authors earlier suggested (6) that teaching be viewed in a slightly different way from that in which employing officials and persons who prepare teachers frequently view it. In changing viewpoints, three perspectives of teaching were taken. First, teaching was viewed as a problem-solving activity. In this, the teacher was viewed as a problem maker, as when he sets objectives for one or more pupils to attain; and then as a problem solver, as when he makes those responses intended to help the pupil or pupils accomplish these objectives.

In a second perspective, one closely related to the first, teaching was viewed as a learned specialization. In this perspective it was assumed that the central difference between less skillful and more skillful teachers is to be found in the constellation of attributes necessary to acquire these skills. It may be noted in this respect that the distribution of the attributes necessary to acquire skill in teaching was hypothesized to be about the same among teachers as among the general college graduate population, so that the major differences between teacher and non-teacher groups in teaching skills were hypothesized to arise on the basis of differential opportunities to learn to teach rather than upon other bases.

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*Numbers refer to references in a numbered bibliography on page 30.

In a third perspective, teaching was viewed as professional activity. The professional dimension of teaching is essentially a normative or value-laden dimension. It not only deals with such matters as ethics and level of competency, but it also mediates the functions of the teacher and the goals he assumes, and hence the problem he deals with. It mediates between the broad demands of society, the demands of local school corporations, and the personal values and desires of the teacher, suggesting, as it were, what teachers ought to do, and determining in part what they do in fact do.

Within the context of the three perspectives, the authors raised the question, "How can the professional skills of teachers best be assessed?" In response to this question, a number of guidelines for assessing such skills were formulated. First, if teaching is problem-solving activity, skill in teaching should best be assessed by means of problems closely resembling those that teachers are called upon to solve. Second, the problems should be predicated, in so far as possible, upon teaching objectives widely recognized by the profession, so that they may be considered normative for teachers. Third, sufficient information bearing on the solution of a problem should be available to make one pattern of teacher response more nearly correct than the alternative patterns of response. And fourth, for purposes of assessing groups of teachers, the problems should be short enough and diverse enough to gather a reasonable array of teacher responses in a particular area, such as teaching intermediate grade arithmetic, within a one-hour period.

The problem. The problem treated in this report is threefold. The initial part of the problem is to determine how much confidence can be placed in problems in teaching arithmetic in grades 3-6 and in teaching reading in grades 2-5 with respect to whether they validly assess skill in teaching in these areas at the designated grade levels. The second part of the problem is to determine some of the characteristics of teachers who are proficient in solving problems in teaching arithmetic on the one hand, and in teaching reading on the other. The third part of the problem is to determine the relationship between skill in solving problems in teaching arithmetic and skill in solving problems in teaching reading. The three parts of the problem are, of course, interrelated, so that information bearing on one part tends also to bear on the other parts.

Sources of data. The data relevant to the problem set forth above were drawn from three pools of information resulting from investigations conducted at the Institute of Educational Research during the past two years.

The first pool of information was acquired by use of seven problems in teaching arithmetic which together composed an instrument called "Form D, Arithmetic." The problems composing Form D were selected after informally trying out some 20 problems in preliminary Forms (A, B, and C) of the instrument. The seven problems selected assessed the problem-solving skill of arithmetic teachers in the following four

areas:* (1) skill in relating arithmetic materials to objectives (two problems), (2) skill in diagnosing pupil difficulties in arithmetic (two problems), (3) skill in elaborating the meanings of fundamental operations (two problems), and (4) skill in ordering arithmetic problems according to their difficulty level for pupils (one problem).

These problems were administered to 136 experienced teachers of arithmetic in grades 3-6, to 185 undergraduates in elementary education, and to 41 non-elementary school teachers. The group of 136 experienced teachers was drawn from two consolidated school systems, one having 45 teachers in grades 3-6 of whom 41 were assessed, and the other having 98 teachers in grades 3-6 of whom 95 were assessed. The group of 185 undergraduates was composed of one group of 80 students who had not yet taken a course in the teaching of arithmetic, a group of 53 students who were measured after completing the methods course and again after completing student teaching, and a group of 52 students who were measured only after student teaching. The group of non-elementary school teachers was composed of nurses, business men, housewives, and secondary teachers, none of whom had taught mathematics or arithmetic and none of whom had taught in elementary school. The information in this first pool was used primarily as a preliminary investigation of the validity of the problems and as a basis for improving the caliber of the problems through item analysis.*

Analysis of the data from the first pool of information indicated that several changes should be made in the seven problems used. Two of the problems were eliminated as unproductive, three of the remaining five were shortened and refined. These modifications resulted in a new set of problems called "Form E, Arithmetic." Because it is convenient to have two forms of a test, an alternate problem was constructed for each problem in Form E. These five alternate problems were combined to make up "Form F, Arithmetic."

These two forms of the problems in teaching arithmetic were then used in gathering a second pool of information by administering them to 101 Indiana teachers of grades 3-6 with 1-10 years of experience and 89 students in elementary education. The group of experienced teachers was drawn from five sources: 32 came from a township system in a city

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*A problem typically required from four to 15 decisions or responses on the part of the teacher. In several problems these decisions were divided into steps, so that it was necessary to complete the earlier steps before advancing to later ones. In no instance should the reader regard a problem as simply an "item," since each problem was actually composed of multiple "items."

*The results of this phase of the investigation were reported in Problem Solving Proficiency Among Elementary School Teachers II: Teachers of Arithmetic Grades 3-6, Monograph of the Institute of Educational Research, Bloomington, Indiana, June, 1960.

of about 500,000 population; 16 came from a system in a city of about 40,000; 21 came from a system in a city of about 18,000; and nine came from a city of about 10,000 population. The remaining 23 were drawn from summer school classes at Indiana University. All of these teachers were assessed with Form E, Arithmetic.

Of the group of 89 elementary education students, 77 were assessed at the beginning of their course in arithmetic methods and again at the completion of student teaching, about eight months later. Half of this group received Form F for the initial test, and half received Form E. All of these students, plus 12 students who had taken arithmetic methods at other times, were assessed on Form E at the completion of student teaching. The information in this pool was used to gain further evidence of the validity of the problems in teaching arithmetic and to clear up a number of questions resulting from the analysis of the first pool of information.*

The third pool of information was acquired by use of nine problems in the teaching of reading ("Reading-Problems"), developed by E. W. Wade. These nine problems assessed the problem-solving skills of reading teachers in seven areas as follows: (1) skill in selecting reading materials at the instructional level of individual children (two problems), (2) skill in grouping children on the criterion of oral reading accuracy (one problem), (3) skill in judging relative improvement in reading over a three-month period (one problem), (4) skill in recognizing the relative reading difficulty level of educational materials for elementary school children (one problem), (5) skill in diagnosing phonetic errors (one problem), (6) skill in diagnosing errors in structural analysis (two problems), and (7) skill in perceiving similarities between instructional reading exercises (one problem). Five of these problems were presented by tape recorder and four were printed problems. All were responded to by paper and pencil methods.*

These nine problems were administered to 176 teachers of grades 2-5, to 97 sophomore students in elementary education who had not yet taken a methods course in teaching language arts or any other methods course, and to 89 students who had completed the core of professional undergraduate courses, including language arts methods and student teaching.* Of the group of 176 teachers, 107 were drawn from a

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*Results of this phase of the investigation were reported in Problem Solving Proficiency Among Elementary School Teachers IV: Further Investigations of Teachers of Arithmetic, Grades 3-6, Monograph of the Institute of Educational Research, Bloomington, Indiana, February, 1961.

*Each problem in teaching reading, like those in teaching arithmetic, required multiple decisions or responses.

*Results of this phase of the investigation were reported by E. W. Wade in Problem Solving Proficiency Among Elementary School Teachers III: Teachers of Reading, Grades 2-5, Monograph of the Institute of Educational Research, Bloomington, Indiana, January, 1961.

consolidated Indiana school system and 69 were nuns teaching in Chicago parochial schools. Of the 107 Indiana teachers, 56 had been assessed one year earlier on Form D, thus yielding information on this group in both the teaching of reading and the teaching of arithmetic. Of the 89 students who had completed language arts and student teaching, 88 were also assessed on Form E, thus yielding information on this group in both teaching reading and teaching arithmetic. However, because of the change in the form of the problems in teaching arithmetic, the reading and arithmetic performance of these 89 student teachers could not be directly compared to the reading-arithmetic performance of the experienced teachers.

A pertinent question with respect to the sources of data described above concerns the reliability of the data. This question requires two different responses, since the notion of reliability has more than one meaning. From the viewpoint of whether the samples used reliably represent a particular population of teachers, it may be said, that the teacher samples represent teachers who teach in the more prosperous communities in central and southeastern Indiana and probably represent Indiana elementary school teachers generally. The sample of nuns, of course, is excepted. The samples of students, on the other hand, represent the population of elementary education students at Indiana University. They undoubtedly do not fully represent other student bodies. From the viewpoint of whether the problems on which these samples were measured were reliable it may be said, first, that the split-half reliability of Form D of the problems was .84 for teachers and .87 for students; second, that the median corrected coefficient of equivalence between Forms E and F of the problems was .88 among unselected graduate students in education; and third, that the split-half reliability of the problems in teaching reading was .87 among teachers. These coefficients were interpreted as reasonably high, considering the nature of the problems being worked with.

## A Survey of the Findings

In accord with the problem investigated, the findings which follow are separated into three parts: those that are most focal in determining how much confidence may be placed in the validity of the problems, those that deal with the teacher characteristics associated with performance, and those that deal with the relationship between problem-solving skill in teaching reading and problem-solving skill in teaching arithmetic.

Variables bearing on the validity of the problems. Those variables which bore most focally on the validity of the problems centered on how different kinds of experiences related to teaching, i.e., different opportunities to learn to teach, affected problem performance. Among the matters of greatest initial interest in this respect was whether the seven problems in Form D arithmetic would differentiate between persons who did and those who did not teach elementary school

arithmetic when the level of education of the two groups was kept approximately equal. This differentiation was of interest for two reasons: first because elementary arithmetic teachers have had wider opportunities to acquire responses relevant to solving problems in teaching arithmetic than have non-elementary teachers, and second because a test of a specialized skill, such as teaching arithmetic, should discriminate persons who practice this skill from persons who do not. If it does not, either the teacher group is not specialized or the test is not a valid measure of the specialization.

To determine whether Form D would make the required differentiation, the mean number of goal-achieving responses of the 136 teachers assessed on this form was compared to the mean number of goal-achieving responses of the 41 non-teachers assessed. The difference in these means was significant at $p < .001$ by the t test.* Both the means and the percentage distribution in four score intervals may be observed in Table 1.

TABLE 1. MEAN SCORES AND PERCENTAGE DISTRIBUTION OF TEACHER AND NON-TEACHER SCORES ON FORM D

| Group | Mean | Per cent in each score interval | | | |
|---|---|---|---|---|---|
| | | 4-11 | 12-14 | 15-17 | 18-30 |
| Teacher | 14.69 | 25 | 25 | 25 | 25 |
| Non-teacher | 10.88 | 54 | 36 | 8 | 2 |

Two matters are of interest with respect to the results shown in Table 1. On the one hand, these results on Form D indicate that 50 per cent of the teachers outscored 90 per cent of the non-teachers, suggesting that the problems in this form differentiated the two groups reasonably well. Yet, on the other hand, half of the teachers performed no better than 90 per cent of the college educated non-teachers. At the time they were obtained these double-edged results definitely suggested that the discriminatory power of the seven problems in Form D might be improved.

The differentiation of teachers from non-teachers, as groups, on Form D left fully open the question of the kind and extent of professional experiences, i.e., opportunities to learn to teach, that might

*Unless otherwise specified, the p values reported are for two-tailed tests.

underlie the performance advantage of the teacher group. While there were many possibilities in this respect, six seemed focal, by virtue of the strategy (6) used by the authors. One was the total opportunities to learn to teach that a teacher had in the institution at which he was prepared. A second was the total opportunities to learn to teach that a teacher had in the kind of teaching situation in which he was employed. A third was the opportunities to learn that were available to a teacher at particular grade levels, e.g., intermediate. A fourth was the methods course relevant to teaching a particular skill, such as reading or arithmetic. A fifth was student teaching; while a sixth was years of teaching experience. These experiences, it should be noted, exist at different levels of specificity. A methods course is a rather specific opportunity to learn to teach, while the total opportunities one has to learn to teach in a particular preparatory institution typically encompass many such specific experiences.

Beginning with the general professional experiences of teachers, the question was asked whether either the kind of preparatory institutions at which a teacher was prepared or the school system in which a teacher was teaching made any difference in the quality of performance. In attempting to answer this question from the data available on Form D, the kind of preparatory institution at which a teacher was prepared was indexed according to the number of students in the student body during 1957-1958, while the kind of teaching situation in which the teacher was employed was indexed by whether the teacher had been employed to teach in a county school, a small city school (city population about 10,000), or a large city school (city population about 40,000).

In the particular sample of 136 experienced teachers drawn, these classifications had implications which later turned out to be of some significance. First, when the preparatory institutions from which the teachers came were indexed according to size of student body, teachers who were prepared at institutions of less than 1,000 students also fell in the class of having all been prepared at privately supported institutions. Typically these small private institutions were located in Indiana. Teachers prepared at institutions of more than 1,000 students, on the other hand, came from both public and privately supported institutions. Second, the selection of teachers from two reasonably large consolidated school systems and the subsequent division of these teachers according to whether they were employed to teach in county, town, or city schools overlooked the possibility that consolidation might be a factor influencing performance, since it made both teaching situations and employment practices more homogeneous than when county and city schools were separately administered.

Analysis of the data with respect to whether teachers from preparatory institutions of less than 1,000 students as opposed to whether they came from institutions of more than 1,000 students, by the chi-square technique revealed that a significantly larger ($p < .02$) proportion of teachers from the small institutions fell in the lower quartile of problem performance. This finding suggested that the kind of institution at which a teacher prepared was related to problem performance.

Analysis of the data with respect to whether the teacher taught in a county, town, or city school revealed that there were no significant differences in performance between these three groups.

In pursuing with Form E whether either kind of preparatory institution or type of teaching situation made a difference in problem performance, both the sampling of teachers and the classification of preparatory institutions were modified. First, two groups of teachers were drawn to explicitly represent small non-consolidated city systems rather than small consolidated systems, while two other groups were drawn to explicitly represent large city systems. Subsequently these teachers were classified according to whether they taught in communities of less than or more than 25,000 population in Indiana. Populations of approximately 25,000 or larger divide the 20 largest Indiana cities from the smaller ones.* Second, rather than dividing preparatory institutions according to size of student body, they were divided according to whether they were publicly or privately supported. Using these divisions, the data were analyzed by two-way analysis of variance to determine whether either preparation or subsequent teaching situation or the interaction between these two variables affected problem performance. Means and variances of these groups may be observed in Table 2. Results of the analysis of these means, with the proper corrections for disproportionality, indicated that both the type of institution at which a teacher prepared ($p<.05$) and the size of community in which he taught ($p<.01$) influenced performance, but that there was no significant interaction between these variables.

A factor which does not explicitly appear in Table 2 but is relevant to its interpretation is that all teachers in small cities who graduated from private institutions graduated from institutions with an enrollment of less than 1,000 persons in the student body. Within the context of the data from both Form D and Form E, the presence of this factor indicates that it was not simply whether a teacher had graduated from a large or small institution or a public or private institution, but whether he had graduated from a small and private institution that made a substantial difference in problem performance in teaching arithmetic. It is also true that whether a teacher had been employed in a small or large community made a substantial difference in performance. The significance of this variable becomes more apparent in later results pertaining to the effects of teaching experience.

Whether both type of preparatory institution and type of teaching situation influence problem solving in the teaching of reading could not be fully answered from the data available in the reading problems because the samples of experienced teachers utilized were both taken from large communities. The question that could be answered was whether type of preparatory institution affected problem performance in reading among the 107 experienced public school teachers. When these teachers were classified according to whether they came from small

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*Over two fifths of the population resides in cities of 25,000 or over.

private or large public or private institutions, no differences in performance were found. This result is of considerable significance for two reasons: first, it indicates that some variables which affect problem performance in teaching arithmetic probably do not equally affect problem performance in teaching reading. Second, because performance on the Reading-Problems is somewhat more closely related to intelligence than is performance on the problems in teaching of arithmetic, it suggests that differences between teachers from small private and large public and private institutions in solving problems in teaching arithmetic arise on the basis of differential opportunities to learn rather than of selective factors such as intelligence.

TABLE 2. FORM E SCORE MEANS AND VARIANCES OF TEACHERS OF GRADES 4-6 WHO WERE FROM PUBLIC AND PRIVATE COLLEGES IN SMALL AND LARGE CITIES*

| Group | Number of teachers | Variance | Mean |
|---|---|---|---|
| Private college, small city | 11 | 20.26 | 26.36 |
| Private college, large city | 22 | 32.37 | 29.23 |
| Public college, small city | 14 | 33.49 | 28.43 |
| Public college, large city | 18 | 32.38 | 33.83 |

*Thirty-two grade 3 teachers were deleted because of grade level biases. Three teachers who had not received degrees from any institutions were also deleted.

Among the more specific experiences that were anticipated to affect the problem-solving performance of a teacher were the grade levels at which he had taught. The significance of this variable, however, depends largely on the particular problems the teacher is asked to solve. For instance, the problems in teaching arithmetic that a primary teacher is called upon to solve differ both in kind and scope from those an intermediate teacher is called upon to solve, whereas both primary and intermediate teachers have to cope with many similar problems in teaching reading. Thus problems in teaching arithmetic designed primarily for intermediate grade teachers might be expected to be unfair to primary grade teachers, while problems in teaching reading might be quite satisfactory for either primary or intermediate grade teachers.

On Form D, the question whether the grade levels at which a teacher had taught influenced performance was investigated by dividing the 136 experienced teachers according to whether they had taught only grades 3 or 4, only grades 5 or 6, or all grades from 3 through 6. Twelve teachers who had taught some in grade 3 and some in grade 6 or some in grade 3 and some in grade 5 could not be placed in these classifications and were therefore deleted. These gross classifications were necessary with this sample because few of the teachers had taught at only one grade level. Analysis of the proportion of teachers in each of the above classes falling in each quartile of the distribution of teacher scores revealed that the grade level at which teaching had been done did not influence performance significantly. In addition to analyzing the group of experienced teachers for possible differences by grade level, the differences in performance between student teachers who taught in kindergarten to grade 2 (K-2) and those who taught grades 3-6 were also investigated. No difference was found between these groups.

The above findings made it appear that grade level was not a significant variable in problem performance. However, in revising Form D into Form E, one of the two problems deleted had been explicitly directed toward grade 3 teachers. This change, together with the other modifications made in the problems in teaching arithmetic, reopened the question about the influence that grade level taught had on performance.

In the sample of 101 experienced teachers measured on Form E, none of the 32 teachers who were teaching third grade had ever taught beyond that level, although some had taught at lower grade levels. Thus, primary teachers in this sample were clearly divided from intermediate grade teachers. The difference in mean problem performance of these groups may be observed in Table 3.

TABLE 3. MEANS, VARIANCES, AND t VALUES OF SCORES FOR TEACHERS OF GRADE 3 VERSUS TEACHERS OF GRADES 4-6 ON FORM E*

| Teachers | n | Variance | Mean | t | p |
|---|---|---|---|---|---|
| Grade 3 | 32 | 60.49 | 24.34 | 3.332 | <.01 |
| Grades 4-6 | 68 | 32.22 | 29.53 | | |

*Teaching experience by grade level was not available for one teacher.

The significant difference in performance between experienced teachers of grade 3 and experienced teachers of grades 4-6 on Form E

raised the question of whether a similar difference existed between elementary education seniors who had done student teaching in grade 3 and those who had done it in grades 4-6. As it turned out, there was no significant difference between these two groups of student teachers.*

Whether grade level taught made a difference in teacher performance on the problems in teaching reading was investigated by classifying teachers according to the grade level at which they had taught during the past five years. Teachers who had taught at more than one grade level during this time were deleted. Analysis of the mean performances of teachers of grades 2, 3, 4, and 5 indicated that there were no significant differences between these groups.

In addition to the grade level at which a teacher had taught, two specific experiences that were anticipated to affect problem-solving performance were a methods course in the skill area in which a given set of problems fell and subsequent student teaching, which involved observation and limited practice in teaching these skill areas. In the investigation utilizing Form D these experiences were treated as independent of each other. To determine the effects on performance of a methods course in teaching arithmetic, 30 elementary education students who were entering the methods course were matched for ACE score and sex to 30 students who had completed the course. Analysis of the difference in the means of these two groups revealed no significant difference.

To determine the effects of student teaching on performance, elementary education students were measured on Form D just before entering student teaching and were measured again with the same form after completing student teaching. The students were then divided according to whether student teaching was done in grades K-2 or in grades 3-6. There was no significant change in the performance of either of these groups as a result of student teaching. These results were probably partly attributable to the fact that the problems in Form D had not been item-analyzed and partly attributable to a failure to utilize an experimental design in which each student served as his own control through both arithmetic methods and student teaching.

In investigating the effects of the two variables in question by use of Forms E and F, Arithmetic, half of the students entering the arithmetic methods course were measured on Form F and half on Form E. After completing both the methods course and student teaching, the whole group was measured on Form E. Analysis of the differences in pre-test performance between the half of the class taking Form E and the half taking Form F revealed that there were no differences attributable to the form of the problems taken. These two halves were subsequently pooled and re-divided according to whether student teaching

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*A comparison of the combined effects of a methods course in arithmetic and student teaching suggests that student teaching below grade 3 does significantly affect performance. This result is shown on page 12.

was done in grades K-2 or grades 3-6.* The data were then analyzed for the difference between the mean pre-test scores of the K-2 and the 3-6 group, for the difference between the mean post-test scores for these groups, and for the difference between the mean pre-test and the mean post-test scores for each group, K-2 and 3-6. The results are shown in Table 4.

TABLE 4. MEANS AND t VALUES OF PRE-TEST AND POST-TEST SCORES FOR ELEMENTARY EDUCATION SENIORS WHO DID STUDENT TEACHING IN EITHER GRADES K-2 OR GRADES 3-6

| Group | n | Pre-test means | Post-test means | t | p |
|---|---|---|---|---|---|
| K-2 | 38 | 20.92 | 24.50 | 3.340* | <.01 |
| 3-6 | 39 | 20.18 | 27.77 | 8.557* | <.001 |
| t | | .045** | 2.473** | | |
| p | | n.s. | .05 | | |

*By t test for correlated groups.
**By t test for independent groups.

The data in Table 4 suggest, first, that an arithmetic methods course and student teaching, in combination, increased problem performance significantly and, second, that student teaching in grades 3-6 led to significantly better post-test performance than student teaching in grades K-2. The latter result is significant not only in suggesting that student teaching experience influences problem performance, but also in adding evidence supportive to the hypothesis that the grade level at which teaching experience occurs is a variable influencing the performance of problems in teaching arithmetic.

In the investigation utilizing the problems in teaching reading, the samples of elementary education students were drawn in a way that precluded the possibility of extracting from the data effects attributable directly to either a language arts methods course or student teaching. The intent in drawing the samples for this investigation was, rather, to determine whether the central core of professional courses occurring between the end of the sophomore year and the end of the senior year contributed to performance. For the seniors tested,

*See page 11.

this core of courses included language arts methods and student teaching, of course, but it also included methods in teaching social studies and arithmetic as well as other professional courses. To determine the probable effects of these courses on performance, 97 elementary education students were assessed near the end of the sophomore year (April), and the mean performance of this group was compared to the mean performance of 89 graduating seniors in elementary education, all of whom had just completed student teaching. The mean of the sophomores was 30.76; the mean of the graduating seniors, 37.78. The difference in means was significant at $p<.01$ by the $t$ test. This result must, of course, be treated as suggestive of the possible effects of professional course work rather than as conclusive.

Whether the number of years of teaching experience a teacher has had makes a difference in performance is the final question to be treated in this section. In order to answer this question it was necessary to exert as much control as possible over the variables which were observed to affect performance and which therefore might become confounded with teaching experience.

In investigating the effects of teaching experience on performance on Form D, the 136 experienced teachers assessed were divided according to whether or not they had graduated from college. Twenty had not, and were deleted. The remaining 116 teachers were subsequently divided according to whether or not they had been prepared at small (less than 1,000 students) or large (more than 1,000 students) institutions; then each of these groups was subdivided into four experience groups: 1-3 years (neophyte), 4-10 years (early career), 11-25 years (middle career), and 26-42 years (late career). Since teaching experience begins at 0 years, a fifth group was added, viz., elementary education seniors from a large institution, who had completed all requirements for teaching, who had done student teaching in grades 3-6, and who, like the teachers were assessed only once on Form D.

In the analysis of the effects of experience on the graduates of large institutions, the 26-42 years category was eliminated because there was an insufficient number of teachers in it. Comparison of the mean performance of the remaining four groups by single classification analysis of variance resulted in an F value of 6.68, significant at $p<.01$. Subsequent analysis of the difference in the mean performance of selected groups by the $t$ test indicated that the principal gap occurred between the group with 0 years of experience and the group with 1-3 years of experience. These results may be observed in Table 5.

Separation of the graduates of large institutions from the graduates of small institutions and the subsequent subdividing of these groups by years of experience left less than five teachers who had graduated from small institutions in the 1-3 and the 26-42 years of experience subgroups. These groups were then deleted. The remaining two subgroups had too few subjects in them to warrant statistical analysis; however, the means and variances were computed. These data, together with the means and variances of the group of graduating seniors in elementary education, are shown in Table 6.

TABLE 5. FORM D MEANS, VARIANCES, AND t VALUES FOR TEACHERS WITH 0, 1-3, 4-10, AND 11-25 YEARS OF EXPERIENCE WHO WERE GRADUATED FROM PREPARATORY INSTITUTIONS OF MORE THAN 1,000 STUDENTS

| Group | n | Variance | Mean | t | p |
|---|---|---|---|---|---|
| 0 years | 35 | 13.58 | 11.56 | | |
| | | | | 3.399 | .01 |
| 1-3 years | 20 | 27.36 | 16.25 | | |
| 4-10 years | 15 | 11.00 | 16.53 | | |
| | | | | 1.760 | n.s. |
| 11-25 years | 14 | 13.92 | 14.22 | | |

A comparison of the relative standing of the 4-10 and the 11-25 years of experience groups shown in Table 6 to that of the same groups in Table 5, and comparison of these groups to the 0 years of experience group suggested the possibility that teaching experience might not have the same effect on the graduates of small and large institutions, since the experienced teachers from small institutions appeared to perform no better than the inexperienced teachers from large institutions.

TABLE 6. FORM D MEANS AND VARIANCES FOR TEACHERS WITH 0 YEARS OF EXPERIENCE WHO CAME FROM LARGE PREPARATORY INSTITUTIONS AND FOR TEACHERS WITH 4-10 AND 11-25 YEARS OF EXPERIENCE FROM SMALL INSTITUTIONS

| Group | n | Variance | Mean |
|---|---|---|---|
| 0 years | 35 | 13.58 | 11.56 |
| 4-10 years | 7 | 17.00 | 11.42 |
| 11-25 years | 10 | 16.67 | 12.50 |

In pursuing the relationship between experience and performance with Form E, it was necessary to control for a greater number of variables than was the case with Form D. All teachers who had not graduated from college and all third-grade teachers were deleted. The group remaining (n = 65) was then divided according to whether graduation was from a private or a public college. The two groups resulting were then subdivided into three experience groups, 1-2 years, 3-5 years, and 6-10 years. The proportion of teachers from large and small communities was

approximately equal in each of the experience groups. To obtain a group with 0 years of experience, all graduating seniors in elementary education who did student teaching in grades 4-6 or who did student teaching in grades K-3 but subsequently were placed in grades 4-6 for their first full-time teaching position, were utilized. The latter procedure insured reasonable comparability between groups with respect to grade level.

For the first analysis, the mean performance of each experience group of public college graduates was compared by single classification analysis of variance. The resulting F value was 3.19, significant at $p<.05$. Subsequent analysis of the difference in mean performance between the 0 years and the 1-2 years group by the $t$ test yielded a value of 7.235, significant at $p<.01$, while the analysis of the difference in means between the 3-5 years and the 6-10 years group by the $t$ test yielded a $t$ value of 1.438, which was not significant. These results may be observed in Table 7.

TABLE 7. FORM E MEANS AND VARIANCES OF TEACHERS WITH 0, 1-2, 3-5, AND 6-10 YEARS OF EXPERIENCE WHO WERE PREPARED AT PUBLIC INSTITUTIONS

| Group | n | Variance | Mean |
|---|---|---|---|
| 0 years | 35 | 31.78 | 27.51 |
| 1-2 years | 12 | 41.27 | 32.00 |
| 3-5 years | 9 | 26.75 | 33.33 |
| 6-10 years | 11 | 47.25 | 29.36 |

The pattern of means in Table 7 is quite similar to that in Table 5. Together they suggest that it is the very early years of teaching experience which have the greatest influence on the performance of teachers graduated from public institutions.

In the second analysis, the mean performance of each experience group of private college graduates was compared with the group with 0 years of experience who were graduated from a public institution by single classification analysis of variance. The resulting F value was 1.15 and was not significant. The means and variances of these groups may be observed in Table 8.

Table 8 suggests that private college graduates with experience perform about the same as public college graduates without experience. However, the trend of the means in Table 8 also suggests that, had a

group of graduating seniors in elementary education from private colleges been utilized, teachers from private institutions might also have shown a distinct rise in performance in the first two years of experience. Whether they would show a gain poses an interesting question for further research.

TABLE 8. FORM E MEANS AND VARIANCES OF TEACHERS WITH 0 YEARS OF EXPERIENCE WHO WERE PREPARED AT PUBLIC INSTITUTIONS AND THOSE WITH 1-2, 3-5, AND 6-10 YEARS OF EXPERIENCE WHO WERE PREPARED AT PRIVATE INSTITUTIONS

| Group | n | Variance | Mean |
|---|---|---|---|
| 0 years | 35 | 31.78 | 27.51 |
| 1-2 years | 10 | 25.29 | 25.80 |
| 3-5 years | 9 | 26.20 | 28.78 |
| 6-10 years | 14 | 31.76 | 29.71 |

One problem raised by comparing Tables 7 and 8 was that teachers from public and private institutions were about equal in performance in the 6-10 years of experience category, which implied that private college graduates continue to gain ground as public college graduates begin to lose ground (although not significantly). In exploring the sources of this result, the teachers on whom these Tables 7 and 8 are based were re-grouped according to whether they taught in large or small communities and then subdivided again into three experience categories. This procedure, however, resulted in unequal proportions of teachers from public and private preparatory institutions in the three experience categories. To correct for this bias,* teachers contributing to the inequality were randomly discarded from categories until equality was achieved. To get a comparison group of teachers with 0 years of experience, all graduating seniors in elementary education who were employed to teach grades 4-6 in communities in excess of 25,000 population were utilized.

For the first analysis of the re-grouped samples, the mean performances of teachers teaching in communities of over 25,000 at each level of experience were compared by single classification analysis of

*A greater proportion of teachers prepared at private institutions than of teachers prepared at public institutions in any one group has the effect of reducing the mean for that group.

variance. The resulting F value was 4.87, significant at $p < .05$. A *t* test of the difference in mean performance of the group with 0 years and that with 1-2 years of experience was not significant, but the differences between the 0 years group and the other groups were significant. The means and variances of these groups appear in Table 9.

TABLE 9. FORM E MEANS AND VARIANCES OF TEACHERS WITH 0, 1-2, 3-5, AND 6-10 YEARS OF EXPERIENCE TEACHING IN CITIES ABOVE 25,000 POPULATION

| Group | n | Variance | Mean |
|---|---|---|---|
| 0 years | 25 | 20.61 | 26.88 |
| 1-2 years | 10 | 54.40 | 30.80 |
| 3-5 years | 10 | 44.62 | 32.20 |
| 6-10 years | 14 | 17.76 | 33.07 |

For the second analysis, the mean performance of teachers teaching in communities of less than 25,000 population in each of three categories of experience, together with that of teachers with 0 years of experience were compared by single classification analysis of variance. The resulting F value was 1.49 and was not significant. The means and variances of these groups may be observed in Table 10.

TABLE 10. FORM E MEANS AND VARIANCES OF TEACHERS WITH 0 YEARS OF EXPERIENCE WHO WERE TEACHING IN COMMUNITIES OF 25,000 AND ABOVE, AND OF TEACHERS WITH 1-2, 3-5, AND 6-10 YEARS OF EXPERIENCE WHO WERE TEACHING IN COMMUNITIES OF LESS THAN 25,000

| Group | n | Variance | Mean |
|---|---|---|---|
| 0 years | 25 | 20.61 | 26.88 |
| 1-2 years | 6 | 17.47 | 28.33 |
| 3-5 years | 6 | 13.37 | 29.83 |
| 6-10 years | 8 | 36.78 | 24.75 |

The data arrayed in Tables 9 and 10 tentatively suggest that the decline in the mean performance of teachers in the 6-10 year group, as shown in Table 7, was probably not a function of preparation at a public institution, but rather a function of the type of teaching situation. It should be noted in this context that, while a drop in mean performance might indicate that some teachers lose skill as experience increases, when cross-sectional sampling methods are used it more likely means that the better problem solvers begin to drop out of small systems beginning about the end of the fifth year of experience.

In the analysis of the relationship between years of experience and performance on the Reading-Problems, the problem of teachers dropping out in the later years of teaching experience was dealt with initially by using only the sample of nuns (n = 69), since these teachers do not migrate or quit teaching. This sample was divided into three groups, 1-15 years, 16-30 years, and 31 or more years of experience. The latter group was deleted as an insufficient sample (n = 11, mean = 34.00) and the difference in the means of the remaining two groups was tested by the *t* test. The results may be observed in Table 11.

TABLE 11. READING-PROBLEMS MEANS AND VARIANCES OF NUNS TEACHING GRADES 2-5 WHO HAD 1-15 AND 16-30 YEARS OF TEACHING EXPERIENCE

| Group | n | Variance | Mean | t | p |
|---|---|---|---|---|---|
| 1-15 years | 38 | 95.79 | 42.05 | 2.17 | $<.05$ |
| 16-30 years | 20 | 61.88 | 47.20 | | |

While the data shown in Table 11 suggest that nuns may increase problem performance in reading for as long as 30 years, it tells nothing about the population of public school teachers in whom the authors are particularly interested in the present paper.

To obtain information on this population, the sample of 107 public school teachers was divided into four experience categories identical to those used in Form D: 1-3 years (neophyte), 4-10 years (early career), 11-25 years (middle career), and 26 or more years (late career). For a category of 0 years of experience, the 89 elementary education seniors who had completed student teaching in grades K-6 were used. Means and variances of each of the groups were then computed. Comparison of the variances of the groups by the *F* test indicated that teachers with 1-3 and 4-10 years of experience were significantly more variable ($p<.01$) than those with 0 years. To achieve homogeneity of the variances, the 0 years group was withheld and a single classification analysis of variance was computed for the four groups of

experienced teachers. The results were significant at $p<.01$. Subsequent analysis of the difference in means between the 4-10 years and the 11-25 years groups by the t test indicated that the mean performance of teachers in this sample significantly deteriorated after the tenth year of experience. This result, it should be noted, is the reverse of that in the sample of nuns, distinctly suggesting that differential attrition occurred among the public school teachers.

To determine whether there was a difference in the means of the 0 years group and the 1-3 years group, a t test utilizing independent estimates of the population variance and the most conservative number of degrees of freedom (df = 30) was performed. The results were significant at $p<.001$. The means, variances, and results of the tests of significance for all five experience groups are shown in Table 12.

TABLE 12. READING-PROBLEMS MEANS AND VARIANCES OF TEACHERS WITH 0, 1-3, 4-10, 11-25, AND 26 OR MORE YEARS OF TEACHING EXPERIENCE

| Group | n | Variance | F | Mean | t |
|---|---|---|---|---|---|
| 0 years | 89 | 98.37 | 2.48** | 37.78 | 4.330** |
| 1-3 years | 31 | 39.67 | | 44.45 | |
| 4-10 years | 26 | 36.64 | 2.68** | 44.00 | 2.041* |
| 11-25 years | 31 | 59.93 | | 40.14 | |
| 26 or more years | 19 | 67.79 | | 36.89 | |

**$p<.01$.
*$p<.05$.

The fact that teachers with 0 years of experience were significantly more variable in performance and showed lower mean performance than teachers with 1-3 or 4-10 years of experience suggests that selective factors as well as learning were operating in the differences between these groups. A reduction in variances and an increase in means among these groups implies that the lower end of the distribution of scores of teachers with 0 years of experience was eliminated in the 1-3 years group.

Teacher characteristics and problem performance. Teacher characteristics were divided into two groups, those that dealt with cognitive or intellectual characteristics, such as intelligence and

achievement, and those that dealt with characteristics involving definite affective components such as attitude and values. Of these two groups, cognitive characteristics in relation to performance were studied exclusively among elementary education students, while characteristics involving affective components were studied among both students and teachers.

The investigation of cognitive characteristics in relation to performance was conducted by use of the ACE Psychological Examination (5), The Cooperative English Test, Test $C_2$ (Reading Comprehension) (3), and the Sequential Test of Education Progress (STEP), Form 3A, Mathematics (4). The ACE and Coop $C_2$ scores for students were obtained from their files. These scores were not available for all students in each sample. STEP scores were obtained only for students who were tested on Form E or Form F of the arithmetic tasks. The STEP was administered to this group during the fourth week of their arithmetic methods course.

On Form D, correlations between ACE and Coop $C_2$ and performance were computed both for students entering the arithmetic methods course and for students completing student teaching. These samples were independent. On Form E and Form F correlations between ACE, Coop $C_2$ , STEP scores, and problem performance were computed for pre-test scores, gain scores, and post-test scores, with students separated according to whether they took Form E or Form F on the pre-test. On the problems in teaching reading, correlations were computed between the ACE, Coop $C_2$, and problem performance only with students who had completed student teaching. The correlations by samples and tests may be observed in Table 13.

On the basis of Table 13, it seems apparent that problem performance in both teaching arithmetic and teaching reading were positively associated with both intelligence and achievement variables, although there was considerable variation between samples and between tests.* With respect to the problems in arithmetic, however, gains in performance under the influence of arithmetic methods and student teaching were distinctly not related either to intelligence or to achievement. This finding suggests that other characteristics, quite possibly associated with motivation, may influence gains in performance. While it is possible that the ceiling of the arithmetic problems made gains among the more intelligent, higher achieving students more difficult, the fact that experienced teachers from public colleges and large cities showed a mean performance very substantially above that of students and the fact that the highest score made by any teacher was 10 points below a perfect score on the problems suggests that the test ceiling was not responsible for the observed effect.

The investigation of problem performance in relation to teacher characteristics involving affective components was done largely on an exploratory basis.

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*The r's between the ACE and the Coop $C_2$ ranged from .75 to .85 in these samples.

TABLE 13. PRODUCT-MOMENT CORRELATIONS BETWEEN PROBLEM PERFORMANCE AND SELECTED COGNITIVE CHARACTERISTICS OF PREPARATORY TEACHERS

| Group | ACE | | Coop $C_2$ | | STEP | |
|---|---|---|---|---|---|---|
| | n | Correlation | n | Correlation | n | Correlation |
| FORM D | | | | | | |
| Before arithmetic methods | 57 | .29* | 57 | .20* | | |
| After student teaching | 46 | .50** | 46 | .45** | | |
| FORM E | | | | | | |
| Pre-test | 34 | .32 | 34 | .45** | 41 | .28 |
| Gain | 34 | -.22 | 34 | -.21* | 41 | .09 |
| Post-test | 34 | .29 | 34 | .36* | 41 | .41** |
| FORM F | | | | | | |
| Pre-test | 28 | .40* | 28 | .45* | 34 | .35* |
| Gain | 28 | .00 | 28 | -.32 | 34 | -.17 |
| Post-test | 28 | .45* | 28 | .19 | 34 | .27 |
| READING PROBLEMS | 45 | .56** | 45 | .55** | | |

*$p < .05$.
**$p < .01$.

Beginning with Form D, responses to the MTAI (2), a measure of teacher attitudes toward pupils, and the Allport-Vernon-Lindzey Study of Values (1), a measure of the dominant interests in personality, were obtained from elementary education seniors who had completed student teaching. These instruments were completed at home by the students, approximately 80 per cent of whom completed and returned both of them. The product-moment correlations between MTAI scores and the score on each scale of the Study of Values for this group, divided according to whether they had been measured once (Group 1) or twice (Group 2) on Form D, are shown in Table 14.*

The correlations shown in Table 14 indicate a relationship between problem performance and teacher attitudes, and the possibility

*As indicated on page 3, part of this group was measured both before and after student teaching, while the other part was measured only after student teaching.

of a relationship between aesthetic values and performance. To determine whether these relationships would hold in a second independent study of student teachers and experienced teachers, both the MTAI and the Study of Values were utilized in the investigation conducted with Form E and F.

TABLE 14. PRODUCT-MOMENT CORRELATIONS BETWEEN MTAI SCORES, STUDY OF VALUES SCORES, AND PERFORMANCE ON FORM D

| Scale | Group 1 (n = 42) | Group 2 (n = 40) |
|---|---|---|
| MTAI | .42** | .33* |
| Theoretical | .16 | .23 |
| Economic | -.07 | -.27 |
| Aesthetic | .14 | .32* |
| Social | -.22 | .41** |
| Political | .06 | .26 |
| Religious | .32 | .21 |

*$p < .05$.
**$p < .01$.

In the investigation with Forms E and F, the MTAI and the Study of Values were responded to at home by education seniors who had completed student teaching. About 80 per cent returned both of the instruments. The two instruments were also responded to at home by the 101 experienced teachers, about 80 per cent of whom returned them. For the analysis, the student teachers were divided according to whether they had done student teaching in grades K-2 or 3-6, while the teachers were divided according to whether they taught in communities larger or smaller than 25,000 population. All grade 3 experienced teachers were deleted to control for grade level differences. The results may be observed in Table 15.

The correlations shown in Table 15 indicate that the relationship between the MTAI and problem performance as obtained on Form D disappeared with the use of Form E. From the data currently available there is little reason to think that a relationship exists between problem-solving performance in teaching arithmetic and teacher attitudes. The very erratic correlations between Study of Values scales and performance also suggests that no substantial relationship exists between these variables. This is not to say that it would be impossible to define a group of teachers among whom there was a positive correlation between the aesthetic scale and problem performance, for

instance, but rather that such a relationship would not characterize teachers generally.

TABLE 15. PRODUCT-MOMENT CORRELATIONS BETWEEN MTAI SCORES, STUDY OF VALUES SCORES, AND PERFORMANCE ON FORM E

| Scale and number of subjects | Group | | | |
|---|---|---|---|---|
| | Student teachers in grades K-2 (n = 31) | Student teachers in grades 3-6 (n = 32) | Teachers in large cities (n = 27) | Teachers in small cities (n = 21) |
| MTAI* | .03 | -.25 | .00 | .06 |
| Theoretical | .41* | .10 | -.19 | .10 |
| Economic | .06 | -.19 | .20 | .01 |
| Aesthetic | .06 | .23 | .48* | -.42 |
| Social | .44* | .20 | -.21 | .12 |
| Political | -.07 | -.14 | .44* | .03 |
| Religious | -.18 | -.41* | .00 | .16 |

*$p<.05$.

*Only 30 student teachers in grades K-2 and 29 in grades 3-6 were included in the correlations with MTAI.

The correlations between MTAI, Study of Values, and performance on the Reading-Problems among student teachers were computed as part of correlations matrices involving several other test scores (e.g., Coop $C_2$, ACE, and Form E Arithmetic). Because no one of these test scores was available for all student teachers who completed the MTAI and Study of Values, several persons who completed the latter two instruments but not all the others were necessarily deleted from the matrices. The correlation between MTAI scores and performance was .08, and the correlation between Study of Values scores and problem performance in teaching reading were as follows: Theoretical, -.08; Economic, .05; Aesthetic, .13; Social, .02; Political, .06; and Religious, -.13. None of the correlations were statistically significant.

Relationships between problem-solving performance in teaching arithmetic and reading. The relationships between problem performance in teaching reading and in teaching arithmetic were determined for one group of experienced teachers (n = 56) and one group of student teachers (n = 88). As was earlier noted, the 56 experienced teachers taught grades 3-5 and were measured on Form D approximately one year before being measured on the Reading-Problems. The student teachers,

on the other hand, were measured on Form E and the Reading-Problems during the same sitting.

To determine the relationship between performance on Form D and performance on the Reading-Problems, correlations were computed between the individual problem scores on Form D, between the individual problem scores on the Reading-Problems, and between each of these scores and the scores for each test. These correlations are shown in Table 16.

TABLE 16. INTERCORRELATIONS BETWEEN INDIVIDUAL PROBLEMS AND TOTAL SCORES FOR FORM D, AND READING-PROBLEMS

| Arithmetic Problems | Reading-Problems | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | Total |
| A | -.01 | -.02 | .06 | .13 | .12 | .20 | .14 | -.08 | .12 | .18 |
| B | -.03 | .16 | .08 | .08 | .10 | .01 | .00 | .33 | .12 | .31 |
| E | -.04 | .23 | .05 | .22 | .05 | .10 | .03 | .17 | .14 | .24 |
| F | .18 | -.10 | -.12 | .03 | .10 | .08 | .41* | .05 | .03 | .14 |
| H | .20 | -.13 | .05 | .11* | .03 | .03 | .01 | .20 | .08 | .13 |
| D | .00 | -.10 | .20 | .41* | .25 | .26 | -.01 | .09 | .31 | .42* |
| G | .03 | -.07 | .00 | -.19 | -.02 | .05 | .10 | -.03 | .11 | -.02 |
| Total | .19 | -.04 | .07 | .19 | .14 | .25 | .29 | .23 | .33 | .50* |

*$p < .01$.

In Table 16, the correlations between total score on Form D and each problem in the reading test may be read in the last row, while the correlations between total score on the Reading-Problems and each problem on Form D may be read in the last columm. Correlations between particular problems on Form D and particular reading problems may be read from the main body of the table. The correlations in the final row and final column of Table 16 indicate that there were rather consistent small positive relationships between total scores on one instrument and individual problem scores on the other instrument. These small positive correlations were consistent enough to yield a .50 correlation between the total scores for each instrument, yet low enough to suggest considerable heterogeneity between ability to solve problems in teaching arithmetic and corresponding ability to solve problems in teaching reading. Clearly, one cannot be certain that an experienced teacher who solves problems well in teaching arithmetic will also solve them well in teaching reading.

The results of correlating performance on the problems in Form E with performance on the Reading-Problems, as shown in Table 17,

suggest that it is still less certain among inexperienced teachers than among experienced teachers that one who solves problems well in teaching arithmetic will solve them well in teaching reading. The correlation between the total scores on the two instruments in this group was only .28, barely significant at the .01 level of confidence.

TABLE 17. INTERCORRELATIONS BETWEEN INDIVIDUAL PROBLEMS AND TOTAL SCORES FOR FORM E AND READING-PROBLEMS

| Arithmetic Problems | Reading-Problems | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | Total |
| 1 | .02 | .04 | .15 | .19 | .04 | .06 | .11 | .25 | .11 | .21 |
| 2 | .04 | .04 | .15 | .20 | .05 | .06 | .23 | .19 | .12 | .24 |
| 3 | .07 | .06 | .08 | .14 | .09 | .08 | .09 | .06 | .30* | .17 |
| 4 | -.23 | .26 | -.10 | .10 | .09 | .15 | .10 | .05 | .19 | .17 |
| 5 | .22 | .08 | -.16 | -.12 | -.18 | .07 | .15 | .05 | .14 | .06 |
| Total | -.03 | .27 | -.07 | .13 | -.02 | .16 | .20 | .19 | .32* | .28* |

*$p < .01$.

A factor relevant to the interpretation of the relationship between problem performance in teaching arithmetic and that in teaching reading is the relationship of these scores to intelligence. Intelligence not only correlated significantly with the total score of each instrument, it also correlated very well with a combined total score for Form E and the Reading-Problems derived by adding together the respective Z scores (transformed scores). The correlation between the ACE and this combined Z score was .63 among student teachers (n = 46). A correlation of this magnitude distinctly suggested the possibility that the correlation of .28 between the reading and arithmetic problems rested largely on a floor built of intelligence. This possibility was confirmed by removing the effects of intelligence from the r of .28 by means of partial correlation, which left a first-order correlation between Form E arithmetic and the Reading-Problems of .04.

On the basis of the relationships between performance on problems in teaching reading and in teaching arithmetic, and the relationships of these two to intelligence, it seems likely that the ability of teachers to solve problems in teaching the elementary school may be generally undergirded by intelligence, but that, beyond this, ability to solve problems in a particular area of teaching, such as reading or arithmetic, depends upon the acquisition of teaching skills specific to that area, and possibly specific to a given range of grades.

## Discussion and Conclusions

In accord with the way in which the problem in the present study was attacked, the initial question for discussion concerns the amount of confidence that can be placed in the validity of problems in teaching reading and in teaching arithmetic. For the present paper this question is largely one of deciding whether the pattern of results shown in the preceding section is a reasonable pattern to expect from specific measures of skill in teaching.*

As was earlier pointed out, the authors have taken the position that one must reasonably expect problems in teaching reading and in teaching arithmetic to distinguish professionally untrained and inexperienced persons from teachers. If they do not make this distinction, there is no rational basis for supposing that they measure skills of particular relevance to teaching. As has been shown, all problems utilized met this expectation, hence some confidence may be invested in all the problems.

In addition to meeting this initial expectation, all of the problems also showed significant associations with intelligence. Again, the authors have elsewhere (6) expressed the notion that valid measures of skill in teaching, on the basis of ability to solve teaching problems, should show such associations. There are two reasons for this expectation: first, ability to solve problems is an intrinsic part of the concept of intelligence. A zero or a negative correlation between intelligence and problem performance in teaching, when other things are equal, would imply that ability to solve problems in teaching is totally divorced from ability to solve problems generally and that, as a profession, teaching is generally devoid of intellectual skills. Now this argument can easily be misunderstood. It does not mean that the most intelligent persons are ipso facto the best teachers, because a person of rather modest intelligence may have had excellent opportunities to learn to teach and hence become a much better teacher than a person of high intelligence who has been deprived of adequate opportunities to learn to teach. Because differences in opportunity to learn to teach increase as the amount of training and experience increases, the authors feel that the relationship between intelligence and skill in teaching may be more accurately demonstrated among preparatory teachers than among experienced teachers.

The second reason for expecting intelligence to be positively associated with skill in teaching is that, given equal opportunity to learn, the more intelligent person should acquire and be able to transfer more responses than the less intelligent person. The trick is, of course, to demonstrate that a particular learning treatment is equivalent for persons of different intelligence and achievement. This

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*The relationships of test results to test rationale as aspects of intrinsic validity and construct validity are dealt with elsewhere by the authors (6; 7).

factor is quite important in making a full interpretation of the finding (shown in Table 13) that intelligence is unrelated, or possibly even negatively related, to gains in performance under arithmetic methods and student teaching. It was earlier suggested that differences in motivation between students may account for this effect, but, in turn, it seems distinctly possible that such differences may have arisen because arithmetic methods and student teaching had been leveled at the average or below average student, with definite attempts to motivate them and to provide learning experiences relevant to their maturity, while the brighter student had been left more to his own devices.

Besides meeting the two expectancies just described, all problems also showed some power to differentiate among teachers with respect to the degree of training and experience. In this respect it seemed to the authors that one would expect a measure of teaching skill not only to make a gross differentiation between untrained and inexperienced persons but to be sensitive to various shades of training and experience. Each of the sets of problems used made such differentiations inasmuch as each was capable of differentiating teachers with approximately 1-10 years of experience from teachers with training but without experience. The Reading-Problems and Form E Arithmetic, of course, also differentiated persons who had completed formal course work and student teaching from those who had not.

Because all problems met the three expectancies outlined above, the authors tentatively concluded that at least minimal confidence might be placed in them. However, beyond this minimal confidence level, the various forms of the problems showed considerable differences in power. Form D showed little power beyond the minimum confidence level. The Reading-Problems also showed comparatively little power beyond this level, although part of the reason for this was that they had not been extensively tried out and refined. Form E, on the other hand, showed a great deal of power in meeting expectancies beyond the minimal level.

One of the important expectancies met by Form E was the ability of this instrument to distinguish not only degrees of training and experience but also the conceptual relevance of teaching experiences to problem solution. The power of Form E to make such distinctions showed up primarily in differentiating both student teachers and teachers according to the grade level taught, with teachers of the primary grades distinctly underperforming intermediate grade teachers.

Another expectancy met by Form E was the differentiation of teachers teaching in large and small communities. While it does not seem essential that a measure of skill in teaching arithmetic makes this differentiation, it nonetheless fits general expectancy with respect to the distribution of teaching skill, since large communities typically have more to offer teachers in the way of salary, professional autonomy, intellectual stimulation, and perhaps in-service work than do smaller communities. These advantages also occur, of course, in many small communities, but in the main they are more closely identified with larger communities.

Still another expectancy met by Form E was the differentiation of teachers prepared at private institutions, and particularly at small private institutions, from teachers prepared at public institutions. This differentiation again fits the pattern of general expectancy in that the small private institutions found in the samples utilized were typically those in which the professional preparation of teachers is handled by extremely small departments. In such departments each instructor must teach an extremely wide range of courses, not all of which he is equally prepared to teach.

On the basis of the total data currently available for Form E, the authors conclude that something more than minimal confidence may be placed in its validity. However, as with any instrument the validity of which rests on meeting multiple criteria (or multiple expectancies), its validity remains open to further demonstration.

Assuming that confidence may be placed in the validity of problems in teaching arithmetic and in teaching reading, the next question concerns how the personal characteristics of teachers and student teachers were related to these measures. Within the scope of the characteristics examined, namely intelligence, reading achievement, arithmetic achievement, teacher attitudes, and dominant interests, it may be concluded that only intelligence was focally related to problem performance. Arithmetic achievement and reading achievement were correlated with performance, but these latter measures are so closely correlated with intelligence that to discuss them as independent of it would be deceptive. There may, of course, be personal characteristics of teachers that are unrelated to intelligence but that are associated with problem performance, but what these characteristics might be remains for the time being unknown.

The third question for discussion concerns the relationship between problem performance in teaching arithmetic and problem performance in teaching reading. From the results obtained it may be tentatively concluded that association between these two measures is positive but low, with the positive association accounted for largely by intelligence, at least among student teachers. The fact that the association between the two measures of problem performance was higher among experienced teachers than among student teachers might be interpreted as an indication of increasing homogeneity of problem-solving skills as a function of teaching experience. However, the fact that experienced teachers were measured on Form D while student teachers were measured on Form E precludes the possibility of a definite conclusion of this point.

In surveying the over-all results obtained with the three instruments used in the present study, two points stand out. First, the intelligence of a teacher has a significant bearing on the extent to which he solves the problems encountered in teaching. In recent years educationists have seemed to minimize the role of intelligence in teaching. Second, the opportunities a teacher has had to learn to teach both during preparation and during teaching experience are among the central determinants of his proficiency in solving teaching

problems. The results suggest that educators might seriously consider placing less emphasis upon personal characteristics, particularly "personality" characteristics, as the determiners of teaching skill and place more emphasis on the development of intellectual skills relevant to the resolution of teaching problems.

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